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## FUNCTIONAL AND TECHNICAL QUALITY - ONE AND SAME QUALITY?

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**Abstract:** This article presents the "Determinants - Structure" Conformity Experiment, which attempts to analyze technical and functional quality. The goal is to measure the functional quality and to present a new aspect of its nature.

Hypothetically an overlay is allowed, designing the determinants of the SERVQUAL methodology on each element of the organization. It is found that each determinant is "responsible" for measuring a certain type of relationship in the internal environment of the organization or between the organization and the external environment. SERVQUAL determinants are dual in nature - they are both criteria and factors of quality at the same time, and a value that must be available throughout the entire production of the product / service.

At the level of the production process and the level of service provision, both qualities - functional and technical - are aligned. They have to be considered as one, because the transformation of resources could not be done without a structure, respectively - adding value.

**Keywords:** nature of quality, SERVQUAL methodology, functional quality, technical quality, added value.

## ФУНКЦИОНАЛНОТО И ТЕХНИЧЕСКОТО КАЧЕСТВО –ЕДНО И СЪЩО КАЧЕСТВО?

**Дарина Минева**

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**Резюме:** Тази статия представя експериментът „Съответствие „Детерминанти – Структура“, чрез който се прави опит за анализ на техническото и функционалното качество. Целта е да измери функционалното качество и да представи нов аспект от неговата природа.

Хипотетично се допуска наслагване, проектиране на детерминантите от методиката SERVQUAL върху всеки един елемент на организацията. Установява се, че всяка една детерминанта е „отговорна“ за измерването на определен тип отношения във вътрешната среда на организацията или между организацията и външната среда. Детерминантите от модела SERVQUAL проявяват двойна природа – те са критерии и фактори на качеството едновременно, и ценност, която трябва да е налична през цялото време на производство на продукт/услугата.

На нивото на производствения процес и на нивото на предоставяне на услугата, двете качества - функционалното и техническото, се изравняват. Те трябва да се разглеждат като едно цяло, защото трансформацията на ресурсите не би могла да се осъществи без структура, съответно - да се добави стойност.

**Ключови думи:** природа на качеството, методика SERVQUAL, функционално качество, техническо качество, добавена стойност.

### INTRODUCTION

In the 21st century, the market has reached the limits of its ability to regulate the productivity of production through market forces. The development of science and technology, business process management, equalize market forces, resulting in increased competition, small product differentiation, continuous growth and alignment of sales of services. Market constraints require a quest for change - shifting focus to consumers.

Measuring consumer satisfaction, in turn, raises the question of the nature of the service at all.

**The aim** of this article is to measure the functional quality and to present a new aspect of its nature

### 1. NATURE AND STRUCTURE OF THE SERVICE

The Consumer Satisfaction Concept defines satisfaction as: "The state of consumer consciousness about the company when their expectations were met or exceeded over the product or service lifecycle" [6].

## HEAVY METAL CONCENTRATIONS IN VEGETABLES WITH GROWTH STAGE AND PLANT SPECIES VARIATIONS

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**Abstract:** Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and heavy metals. Heavy metals are one of a range of important types of contaminants that can be found on the surface and in the tissue of fresh vegetables (Bigdeli and Seilsepour, 2008). A number of elements, such as lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), chromium (Cr), Copper (Cu) and Selenium (Se) (IV) can be harmful to plants and humans even at quite low concentrations. Soil pollution is caused by misuse of the soil, such as poor agricultural practices, disposal of industrial and urban wastes, etc.

The research was conducted in order to see the concentration of heavy metals in leafy vegetables spinach – *Spinacia oleracea*, garlic – *Allium sativum* and onion – *Allium cepa*. Spinach, garlic and onion seeds were sown on 23<sup>rd</sup> November 2011; samples for analysis of these plants were taken at different stages – 15, 30, 45 and 60 days after sowing.

**Keywords:** Vegetables, soil, heavy metals, concentrations, plant species, correlation coefficient.

### INTRODUCTION

The consumption of vegetables and fruits as food offer rapid and least means of providing adequate vitamins supplies, minerals and fibre. Vegetables are used as food include those used in making soups or served as integral parts of the main sources of a meal. Each plant species has its nutritive requirements differing from others. Thus different plants supported by identical solutions will contain varying concentrations of minor and macro elements. Application of industrial effluent decreases the budding and growth rate of vegetables. Leafy vegetables occupy a very important place in the human diet, but unfortunately constitute a group of foods which contribute maximally to nitrate and other anions as well as heavy metals consumption. The excessive application of nitrogen and other inorganic fertilizers and organic manures to these vegetables can accumulate high levels of nitrate and other anions as well as heavy metals. And consequently their consumption by humans and animals can pose serious health hazards. Although some heavy metals such as Cu, Zn, Mn and Fe are essential in plant nutrition, many of them do not play any significant role in the plant physiology. The uptake of these heavy metals by plants especially leafy vegetables is an avenue of their entry into the human food chain with harmful effects on health.

Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and heavy metals. Heavy metals are one of a range of important types of contaminants that can be found on the surface and in the tissue of fresh vegetables (Bigdeli and Seilsepour, 2008). A number of elements, such as lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), chromium (Cr), Copper (Cu) and Selenium (Se) (IV) can be harmful to plants and humans even at quite low concentrations (Bowen, 1979). Soil pollution is caused by misuse of the soil, such as poor agricultural practices, disposal of industrial and urban wastes, etc. (Buchaver, 1973). Soil is also polluted through application of chemical fertilizers (like phosphate and Zn fertilizers), and herbicides (Demi'rezen and Aksoy, 2004). Heavy metal accumulation in soils is of concern in agricultural production due to the adverse effects on food quality, crop growth (Ma *et al.*, 1994; Msaky and Calvert, 1990; Fergusson, 1990) and environmental health.

Soil pollution by heavy metals is great concern to public health (Goyer, 1996). The source of heavy metal in plant is the environment in which they grow and their growth medium (soil) from which heavy metals are taken up by roots or foliage of plants (Okonkwo *et al.*, 2005). Plants grown in polluted environment can accumulate heavy metals at high concentration causing serious risk to human health when consumed. Moreover, heavy metals are toxic because they tend to bioaccumulate in plants and animals, bioconcentrate in the food chain and attack specific organs in the body (Akinola *et al.*, 2006; Chatterjee and Chatterjee, 2000).

Plant species have a variety of capacities in removing and accumulating heavy metals. So there are reports indicating that some plant species may accumulate specific heavy metals (Markert, 1993). The uptake of metals from the soil depends on different factors, such as their soluble content in it, soil pH, plant species, fertilizers, and soil type (Lubben and Sauerberck, 1991). Vegetables, especially leafy vegetables, accumulate higher amounts of heavy metals (Sharma and Kansal, 1986). Roots and leaves of herbaceous plants retain higher concentration of heavy metal than stems and fruits (Yargholi and Azimi, 2008). There are limited studies on heavy metal content at different growth stages of vegetables, the most studies focused on the status of metal content in edible parts of vegetables. And an investigation of the literature also shows a scarcity of data on comparison of metal content at different leafy vegetable species. Therefore, the present study was undertaken to compare and investigate the concentration levels of heavy metals (Pb, Cd, Ni, Co, and Cr) at different growth stages of the commonly grown leafy vegetables; to find out a growth stage, which stage is less content of heavy metals; to quantify the concentrations of heavy metal content by different vegetable species.

#### **PLANT AND SOIL SAMPLE COLLECTION**

Plant and soil samples were collected at four growth stages of vegetables at 20, 30, 40, and 50 days after sowing. The samples were collected carefully using hand trowel to dig the soil around the plant and the plants were pulled out carefully, ensuring that no part of the root was lost. Plant samples were kept in separate polythene bags and properly labeled. Soil samples were collected at a depth of 0-15 cm from the same point of collecting plant samples. The samples were kept in polythene bags and labeled properly. The plant and soil samples were analyzed in the laboratory.

#### **PREPARATION AND PRESERVATION**

The vegetable samples were washed in fresh running water to eliminate dust, dirt, possible parasites or their eggs and then again washed with deionized water. The clean vegetable samples were air dried and placed in an electric oven at 65 °C for 72–96 h depending on the sample size. The dried vegetables samples were homogenized by grinding using a ceramic coated grinder used for metal analysis.

All soil samples were spread on plastic trays and allowed to dry at ambient temperature for 8 days. The dried samples of soils were ground with a ceramic coated grinder and sieved through a nylon sieve. The final samples were kept in labeled polypropylene containers at ambient temperature before analysis.

#### **DIGESTION AND DETERMINATION**

One gram of dry matter was weighed into 50-ml beaker, followed by the addition of 10 ml mixture of analytical grade acids HNO<sub>3</sub>: HClO<sub>4</sub> in the ratio 3:1. The digestion was performed at a temperature of about 190 °C for 1.5 h. After cooling, the solution was made up to a final volume (30 ml) with distilled water in a volumetric flask. The metal (Pb, Cd, Ni, Co, and Cr) concentrations were determined by atomic absorption spectrometry using a PERCIN ELMER 5000. Analysis of each sample was carried out three times to obtain representative results and the data reported in µg/g (on a dry matter basis).

#### **RESULTS AND DISCUSSION**

The consumption of vegetables and fruits as food offer rapid and least means of providing adequate vitamins supplies, minerals and fibre. Vegetables are used as food include those used in making soups or served as integral parts of the main sources of a meal. Each plant species has its nutritive requirements differing from others. Thus different plants supported by identical solutions will contain varying concentrations of minor and macro elements. Application of industrial effluent decreases the budding and growth rate of vegetables. Leafy vegetables occupy a very important place in the human diet, but unfortunately constitute a group of foods which contributes maximally to nitrate and other anions as well as heavy metals consumption. The excessive application of nitrogen and other inorganic fertilizers and organic manures to these vegetables can accumulate high levels of nitrate and other anions as well as heavy metals. And consequently their consumption by humans and animals can pose serious health hazards. Although some heavy metals such as Cu, Zn, Mn and Fe are essential in plant nutrition, many of them do not play any significant role in the plant physiology.

The uptake of these heavy metals by plants especially leafy vegetables is an avenue of their entry into the human food chain with harmful effects on health. Vegetables act as neutralizing agents for acidic substances formed during

digestion. As human activities increases, especially with the application of modern technologies, pollution and contamination of the human food chain has become inevitable. The uptake of heavy metals by plants grown in polluted soils has been studied to a considerable extent. Heavy metal contamination in vegetables cannot be underestimated as these food stuffs are important components of human diet. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance. International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risk, these metals pose to food chain contamination. Rapid and unorganized industrialization and urbanization have contributed to the elevated levels of heavy metals in the urban environment in developing countries Heavy metals are non biodegradable and persistent environmental contaminants which may be deposited on the surfaces and then adsorbed into the tissues of the vegetables. Plants take-up heavy metals by absorbing them from deposits on the parts of the plants exposed to the air from polluted environment as well as from contaminated soils. Watercontamination by heavy metals in some areas is practically inevitable due to natural process (weathering of rocks) and anthropogenic activities (industrial, agricultural and domestic effluents). Waste water from the industries of mining, electroplating, paint or chemical laboratories often contains high concentrations of heavy metals, including Cadmium (Cd), Copper (Cu) and lead (Pb). These elements, at concentrations exceeding the physiological demand of vegetables, not only could administer toxic effect in them but also could enter food chains, get biomagnified and pose a potentialthreat to human health. Heavy metal contamination in agricultural soils from wastewater irrigation is ofserious concern due to its implications on human health. Vegetables can absorb metals from soil as well as from deposits on the parts of the vegetables exposed to the air from polluted environments.

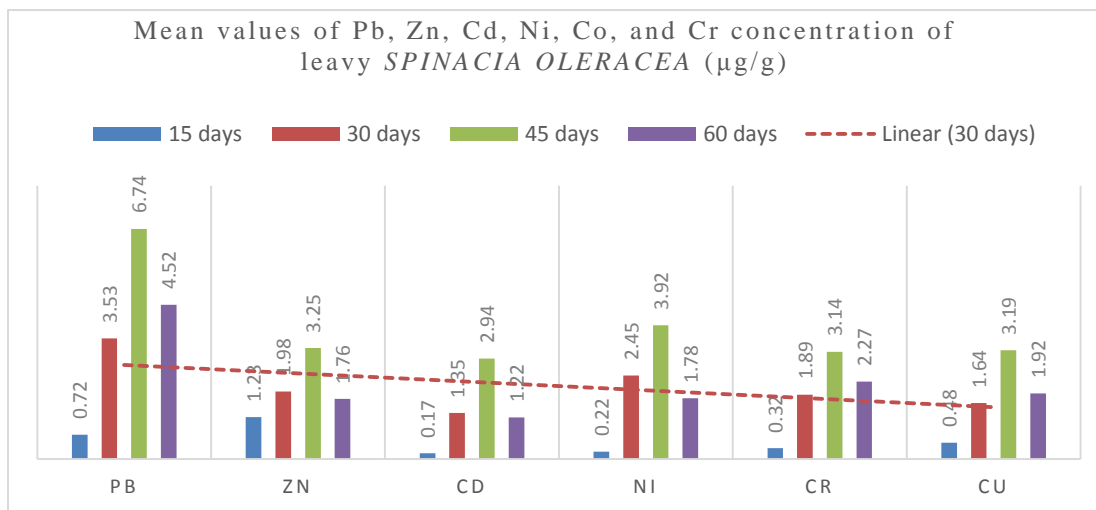
The results (Table 1, table 2, Table 3, Table 4) showed that the concentration of lead, zinc, cadmium, nickel, and cobalt increased with increasing age of the plant. The percentage of increase of heavy metals was higher from 15<sup>th</sup> to 30<sup>th</sup> day, compared to that between 30<sup>th</sup> and 45<sup>th</sup> day.

The concentration of heavy metals gradually increases in the early stage of the plant growth, and gradually declines in later stages of growth. The significant differences ( $P < 0.01$ ) were observed between the mean metal concentrations in the three vegetables species. Higher concentrations of lead and cadmium were found in spinach, compared to garlic and onion. The order of heavy metal level in different vegetables was  $Cd < Co < Pb < Ni < Cr$ . The value of the correlation coefficient soil-plant was highest for cadmium and lowest for nickel.

The result indicated that there was significant difference ( $P < 0.01$ ) in mean heavy metal content in the three vegetable species. The result showed significantly higher level of Pb concentration in amaranth compared to spinach and red amaranth. Spinach exhibited significantly higher levels of Cd and Cr than the other vegetables.

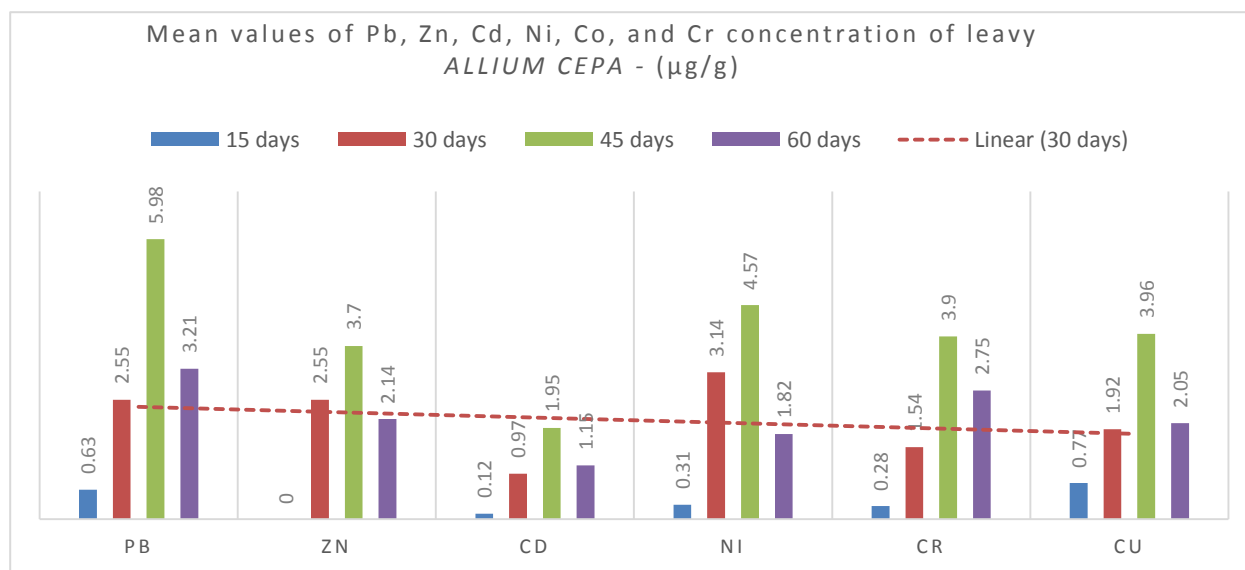
**Table 1: Mean values of Pb, Zn, Cd, Ni, Co, and Cr concentration of leafy *Spinacia oleracea* (µg/g)**

<i>Spinacia oleracea</i>	Pb	Zn	Cd	Ni	Cr	Cu
15 days	0.72	1.23	0.17	0.22	0.32	0.48
30 days	3.53	1.98	1.35	2.45	1.89	1.64
45 days	6.74	3.25	2.94	3.92	3.14	3.19
60 days	4.52	1.76	1.22	1.78	2.27	1.92



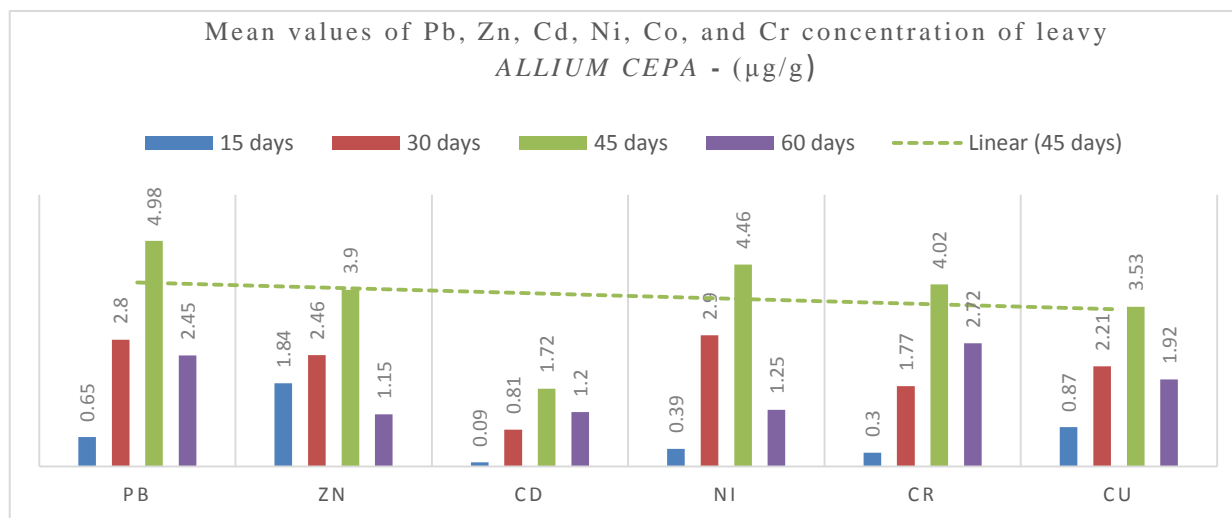
**Table 2: Mean values of Pb, Zn, Cd, Ni, Co, and Cr concentration of leavy *Allium sativum* (µg/g)**

<i>Allium sativum</i>	<i>Pb</i>	<i>Zn</i>	<i>Cd</i>	<i>Ni</i>	<i>Cr</i>	<i>Cu</i>
15 days	0.63	1.78	0.12	0.31	0.28	0.77
30 days	2.55	2.55	0.97	3.14	1.54	1.92
45 days	5.98	3.70	1.95	4.57	3.90	3.96
60 days	3.21	2.14	1.15	1.82	2.75	2.05



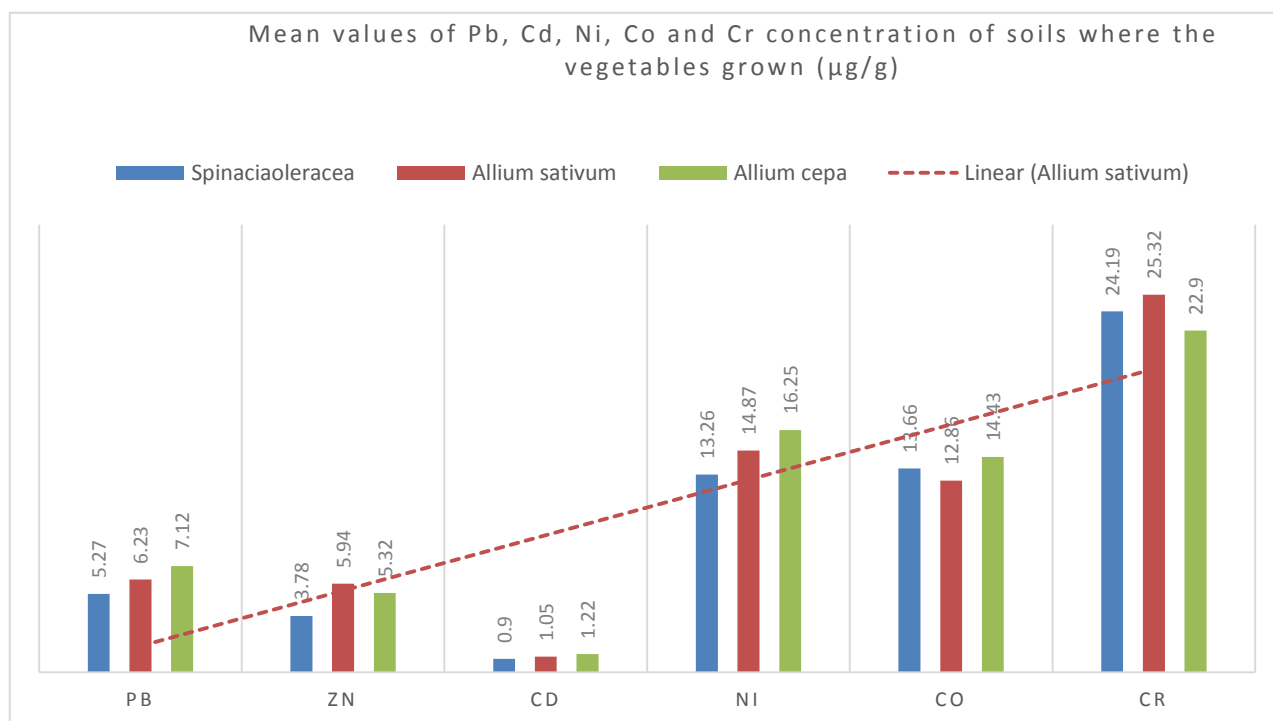
**Table 3: Mean values of Pb, Zn, Cd, Ni, Co, and Cr concentration of leavy *Allium cepa* - (µg/g)**

<i>Allium cepa</i>	<i>Pb</i>	<i>Zn</i>	<i>Cd</i>	<i>Ni</i>	<i>Cr</i>	<i>Cu</i>
15 days	0.65	1.84	0.09	0.39	0.30	0.87
30 days	2.80	2.46	0.81	2.90	1.77	2.21
45 days	4.98	3.90	1.72	4.46	4.02	3.53
60 days	2.45	1.15	1.20	1.25	2.72	1.92



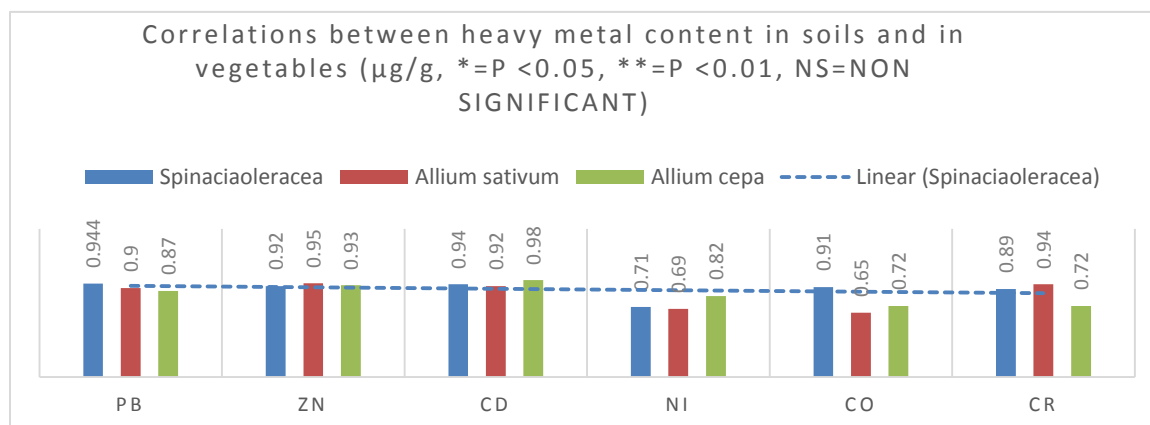
**Table 4: Mean values of Pb, Cd, Ni, Co and Cr concentration of soils where the vegetables grown ( $\mu\text{g/g}$ )**

Vegetable	Pb	Zn	Cd	Ni	Co	Cr
<i>Spinacia oleracea</i>	5.27	3.78	0.90	13.26	13.66	24.19
<i>Allium sativum</i>	6.23	5.94	1.05	14.87	12.86	25.32
<i>Allium cepa</i>	7.12	5.32	1.22	16.25	14.43	22.90



**Table 5: Correlations between heavy metal content in soils and in vegetables ( $\mu\text{g/g}$ ,  $*=p < 0.05$ ,  $**=p < 0.01$ , ns=non significant)**

Vegetable	Pb	Zn	Cd	Ni	Co	Cr
<i>Spinacia oleracea</i>	0.944	0.92	0.94	0.71	0.91	0.89
<i>Allium sativum</i>	0.90	0.95	0.92	0.69	0.65	0.94
<i>Allium cepa</i>	0.87	0.93	0.98	0.82	0.72	0.72



**Table 4.** Transfer factor ( $\pm$ , standard deviation) of Pb, Zn, Cd, Ni, Co and Cr for the soils to vegetables species.

Vegetable	Pb	Zn	Cd	Ni	Co	Cr
<i>Spinacia oleracea</i>	0.322 $\pm$ 0.014	0.265 $\pm$ 0.012	0.783 $\pm$ 0.016	0.338 $\pm$ 0.007	0.093 $\pm$ 0.003	0.312 $\pm$ 0.006
<i>Allium sativum</i>	0.314 $\pm$ 0.012	0.231 $\pm$ 0.010	0.462 $\pm$ 0.010	0.351 $\pm$ 0.023	0.125 $\pm$ 0.005	0.279 $\pm$ 0.003
<i>Allium cepa</i>	0.325 $\pm$ 0.005	0.314 $\pm$ 0.008	0.731 $\pm$ 0.019	0.346 $\pm$ 0.017	0.134 $\pm$ 0.003	0.296 $\pm$ 0.002

## CONCLUSIONS

Heavy metal content in different leafy vegetables varies significantly. The content varies with time of harvesting and stage of maturity of crops. The Cd and Cr contents in leafy vegetables in this study were detected higher while Pb and Ni were within the permissible limits as per the WHO standard but all the metals were within the maximum allowable level. The magnitude of time dependence of plant metal concentration variations differed among crop species and metals. Further research is needed to obtain more specific information about the effect of age of the plants on accumulation and distribution of the heavy metal in the different plant parts, variations in uptake between different plant species, cropping history and fertilization.

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